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Quarterly Progress Report
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The Plexiglas headholder device has been modified to correct for minor operational problems discovered during use at the MR center. Some components were modified to provide additional strength. We demonstrated the ability to machine the unit from Delrin and Ertalyte as well, but the laser cutting facility we utilize for machining is unable to smoothly cut these materials. We will provide Plexiglas units as the principal released production model. Delrin and/or Ertalyte units will be available to any customer who wishes one, but will need to be machined by standard milling processes. Delrin itself offers no major advantage over Plexiglas in strength, and actually has a slight proton NMR spectrum (insignificant for most MR applications). Ertalyte provides approximately 20-25% increased flexional and torsional strength and has no proton spectrum, but is more difficult to machine. We met with our mechanical engineer and the laser cutting facility outside Chicago recently to work out the final machining/engineering problems and have placed an order for 6 units to be built. These should be ready by mid to late November and will be provided for routine use locally and to our remote beta test sites. Data of the actual movement extremes and average movement during a subject run using our production model have not been collected as the final production model has not yet been obtained .... This will be accomplished in the next 6 weeks and the resulting analysis reported in the December monthly report and our next quarterly report.

Additionally, we have designed and built a functioning prototype of a hand mounted 5-button response mechanism which is shaped to fit a human hand (both left or right hand versions). It has worked successfully in the magnet bore and is currently being rebuilt with new cabling and shielding components so it can function both separately and as an integrated unit with the other hardware components. The next level prototype will be developed during the remaining weeks of October and November. We expect a model suitable for production to be ready by mid to late December.

Several discussions have been held regarding RF shielding of the various electrical components. We have successfully shielded our button response unit and microphone assembly, but have had recurrent problems with the electrostatic headphones. This problem is most likely associated with a floating ground that exists in the circuitry as built by the manufacturer. Our recent interactions with two RF engineers we have brought on as consultants, has led us to reconstruct all the cabling components to provide complete continuity of shielding, passing thru our filtering components housed in aluminum boxes, and to be grounded both at the control room feed-thru conduits and the magnet base itself. An additional filter is being added in the mid region of the cabling from the magnet across the room, due to the possibility of wave reflection in the cable (its length is longer than the 7.8 foot quarter-wavelength of 63.8 MHz RF emitted by the MR scanner transmitter). These components have just been rebuilt and will be tested the 3rd week of October.

The magnetic field in the 1.5 T magnet room was mapped utilizing a hand held gaussmeter to gain a better understanding of the field problems we are exposing our instrumentation to. We also ascertained the effectiveness of using mu-metal as shielding in the magnetic room --- attenuation is more than adequate to shield electrical components if necessary. We hope to avoid the use of mu-metal if possible due to the problems associated with bringing ferromagnetic materials in close proximity to the magnet bore, but it is available as an option if we need it. We continue to bear in mind that the shielding at our facility may be more effective than some other facilities, and thus are allowing for this in our development engineering.

The LCD display has been the most difficult item, but we have succeeded in overcoming the engineering problems associated with driving an LCD module deep in the bore of a 1.5 T magnet. Earlier this year we established that certain LCD module types can indeed function superbly in the magnet bore of our 1.5 T magnet. In spite of the engineers at the manufacturer's tech support telling us we could never do it, we have successfully driven a color

640x480 resolution active matrix display from 30 feet away (sufficient to go from magnet bore to control room). This required isolating the troublesome components then separating them from the LCD module PC board and mounting them at a distance to prevent disruption of their operation by the magnetic field. We have established a satisfactory combination of LCD module and driver and have successfully tested it in the magnet using spiral and EPI functional scans with no problem. We did have interference problems during the T1 weighted spin echo sequences, but as these runs were in an unshielded configuration we weren't surprised. We are presently developing appropriate RF shielding. We expect to build a functioning prototype model which will be usable by mid December but don't expect a production model before late January to February. We are continuing to pursue development of the stereoscopic LCD display with VGA modules as well. The main problem with them has been obtaining the smaller LCD modules, but it appears we finally have a source. Now that the engineering problems have been overcome, development is expected to go smoothly. We can do it with 0.7 inch diagonal 320x240 resolution modules (1/4 VGA), but don't feel this is adequate resolution for what we are trying to achieve.

Our electrostatic headphone/microphone unit for audio stimulus and communication are functioning very well, but still in experimental prototype. We have just designed a housing and support device for the headphones to provide passive noise reduction and are building a first prototype of that support structure now. The button response unit (5 button left and/or right handed) is functional, but not 'elegant in design' yet. We have a design for the next experimental prototype, and I'm confident this item will move quickly though that phase to a production model. We are releasing these items for evaluation locally at the University of Pittsburgh and two of our remote sites.

Active noise cancellation studies have only been pursued marginally. We obtained sound recordings of the various pulse scan sequences utilizing microphones mounted in the magnet bore (the same microphones we are using in our audiovisual equipment). We mounted one fixed in the region of a subject's mouth, then located the second one next to it for sound recordings as a control. Then we moved the second microphone to 5 additional locations about the head to obtain recordings for the purpose of analyzing phase differences. We also acquired a commercial set of noise reduction headphones commonly used in airliners for passenger comfort. These were tested in the magnet room just to ascertain the effectiveness of this approach. They were taken up to the face of the magnet, but not into the bore as they had not been stripped of all ferromagnetic components (a difficult task for the set we had). The noise reduction capability did provide a very significant reduction of low to low-mid frequency background noise in the room and a noticeable but not extensive reduction of the slightly higher frequency audible gradient noise due to spin echo and spiral pulse scan sequences. Based on this information, it does seem feasible to pursue an experimental prototype which is tuned to low and mid frequency ranges. There was no detectable cancellation of the significantly more intense and higher pitched audible gradient noise of the EPI scan sequences, and we see no immediate solution to this problem. It is increasingly difficult to cancel noises at higher frequency ranges. Since it is our intent to run principally spiral scan pulse sequences (> 99 % of the time) we will focus on the noise cancellation problem in the low-mid frequency range covering the spiral and spin echo sequences.

No modifications or additions to paradigm procedures were made during this period.

We are presently in the process of releasing the Graphical User Interface (GUI) with the underlying C++ code for data transfer, reconstruction, analysis and imaging to two of our remote test sites (Univ. of Florida and Univ of CA at Santa Barbara) and to fMRI programmers and researchers locally at Carnegie-Mellon University, the University of Pittsburgh, and the University of Pittsburgh Medical Center. We are starting to test it in our own research group at Pitt right now. I can foresee a version 1.0 release of the software by late December. The GUI has been written in Java, which has progressed very far from its beta release earlier this year (currently version 1.1.4 on Windows 95/NT platform and 1.1.3 on Linux). There has been a flood of new tools and widgets available from vendors and known bugs have been addressed promptly. Java's capability was expanded greatly in version 1.1 and we are satisfied we made the correct decision to write our code in the Java language. We have interacted very closely with the Carnegie-Mellon University cognitive science computer programmers to ensure we are providing a package that satisfies the needs of the research community at large. We have provided a versatile user interface to permit plug-in routines of any type to be incorporated easily into the existing GUI by the end user.

There has been a substantial amount of work accomplished on a help system for the new GUI. It has been written in HTML format and will be accessible by any of the major browser packages that can display HTML (also spawned from within the GUI). The new version of Java enabled us to incorporate button help (along with many other features we weren't able to provide with the 1.0 version). Tutorials were rewritten for the GUI from their previous versions which supported the LISP interface currently in use. (Again, we are just starting to use the GUI in the lab and are abandoning the LISP interface).

Our own C++ code has been modified extensively over the past 6 months to provide an order of magnitude increase in speed of data reconstruction (mostly by efficient tuning of the software by the lead programmer). Several statistical routines were added to the statistical analysis package and external routines for brain registration (Automated Image Registration from UCLA) and a brain flattening routine from San Diego were incorporated as plug-ins. The imaging software was demonstrated to the biweekly joint Carnegie-Mellon / Univ of Pitt development meeting earlier this summer and constructive feedback was incorporated into a new version of the viewer to satisfy the needs of more researchers.

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